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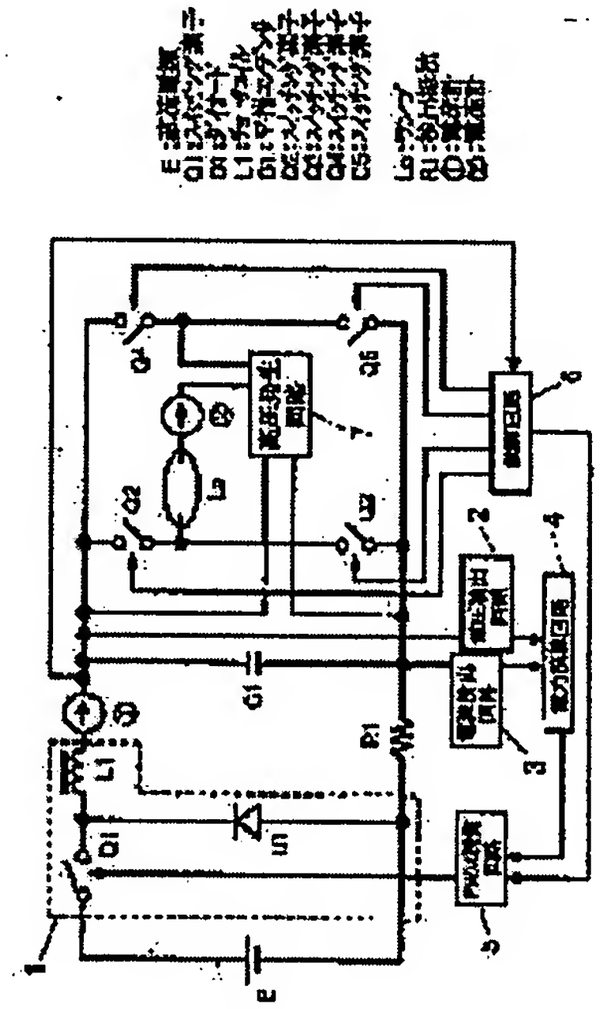
(54) HIGH PRESSURE DISCHARGE LAMP DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To drastically reduce the flicker (flickering of discharge arc) that happens when lighting a high pressure discharge lamp in the high pressure discharge lamp lighting device that lights the high pressure discharge lamp by supplying an AC lamp current of low frequency.
SOLUTION: At least one cycle of high frequency operation is inserted immediately before polarity inversion at each half-cycle of the AC lamp current waveform of low frequency. And the peak value of the lamp current waveform at the time of the operation of the high frequency inserted immediately before the polarity inversion at each half-cycle is made higher than the peak value of the lamp current waveform at the operation of the low frequency. Further, the peak value on the same polarity side only as the lamp current immediately before the polarity inversion is made higher or longer in time span for that portion.



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CLAIMS

[Claim(s)]

[Claim 1] The high-pressure electric-discharge lamp lighting device characterized by inserting one period of high frequency operation in a power source, a high-pressure electric-discharge lamp, and a high-pressure electric-discharge lamp just before the polarity reversals for every half period of the alternating current lamp current wave form of low frequency in the high-pressure electric-discharge lamp lighting device which consists of electronic ballast which supplies the alternating current lamp current of low frequency.

[Claim 2] The high-pressure electric-discharge lamp lighting device characterized by making high peak value of the lamp current wave form at the time of the high frequency operation inserted just before the polarity reversals for every half period of that rather than the peak value of the lamp current wave form at the time of low frequency actuation in the high-pressure electric-discharge lamp lighting device of claim 1.

[Claim 3] The high-pressure electric-discharge lamp lighting device characterized by only the same polarity side as the lamp current in front of polarity reversals making high peak value of the lamp current wave form at the time of high frequency operation in the high-pressure electric-discharge lamp lighting device of claim 2.

[Claim 4] The high-pressure electric-discharge lamp lighting device to which only the part which made high peak value of the lamp current wave form at the time of high frequency operation is characterized by enlarging time amount width of face in the high-pressure electric-discharge lamp lighting device of claim 3.

[Claim 5] The high-pressure electric-discharge lamp lighting device characterized by inserting two or more periods of high frequency operation in the high-pressure electric-discharge lamp lighting device of claim 1.

[Claim 6] The high-pressure electric-discharge lamp lighting device characterized by making high peak value of the lamp current wave form at the time of the high frequency operation inserted just before the polarity reversals for every half period of that rather than the peak value of the lamp current wave form at the time of low frequency actuation in the high-pressure electric-discharge lamp lighting device of claim 5.

[Claim 7] The high-pressure electric-discharge lamp lighting device characterized by only the same polarity side as the lamp current in front of polarity reversals making high peak value of the lamp current wave form at the time of high frequency operation in the high-pressure electric-discharge lamp lighting device of claim 6.

[Claim 8] The high-pressure electric-discharge lamp lighting device to which only the part which made high peak value of the lamp current wave form at the time of high frequency operation is characterized by enlarging time amount width of face in the high-pressure electric-discharge lamp lighting device of claim 7.

[Claim 9] The high-pressure electric-discharge lamp lighting device characterized by only the same polarity side as the lamp current in front of polarity reversals making high peak value of the lamp current wave form at the time of high frequency operation only as for the last period in the high-pressure electric-discharge lamp lighting device of claim 5.

[Claim 10] The high-pressure electric-discharge lamp lighting device to which only the part which made high peak value of the lamp current wave form at the time of high frequency operation is characterized by enlarging time amount width of face in the high-pressure electric-discharge lamp lighting device of claim 9.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the technique which controls remarkably the flicker (fluctuation of a discharge arc) generated while a high-pressure electric-discharge lamp lights up in the high-pressure electric-discharge lamp lighting device which an alternating current lamp current is supplied [lighting device] to a high-pressure electric-discharge lamp, and makes a high-pressure electric-discharge lamp turn on.

[0002]

[Description of the Prior Art] If lighting actuation of the high-pressure electric-discharge lamp (it abbreviates to a lamp hereafter) is carried out with the alternating current lamp current of a low frequency, it not only prevents that the electrode of a lamp is eaten away quickly, but it is known that a lamp can be made to turn on at comparatively high effectiveness. The discharge arc which is near the electrode as a problem about lighting of such a lamp depending on electrode temperature and the condition of the electrode surface may become unstable. As one of the cause of the, the origin of a discharge arc may jump at spot with one [another] more from one spot in an electrode surface. When an electrode surface is too cold, near the electrode, it is very thin, therefore the origin of an electrode surface is overheated, and, thereby, a discharge arc comes to produce a minute motorbike. If the origin of a discharge arc jumps among these minute motorbikes during lighting actuation,

a flicker will arise in a high-pressure electric-discharge lamp. This flicker is produced also when electrode temperature is too high. Under this condition, an electrode material displaces continuously, evaporates and causes the instability of a discharge arc.

[0003] In operating a high-pressure electric-discharge lamp by alternating current, the electrode of a lamp functions as cathode in one half period of a lamp current, and functions as an anode plate in the half period of another side. It can be said during these half periods that an electrode is in a cathode phase or an anode plate phase, respectively. The electrode material removed from an electrode in an anode plate phase returns to an electrode as an ionic current in a cathode phase. These migration processes opt for the behavior of electrode temperature during a round term of a lamp current. The reason is that the time dependency of the electrode temperature in an anode plate phase differs from the electrode temperature dependence in a cathode phase. For this reason, electrode temperature continues during [whole] a round term of a lamp current, it changes strongly, and a discharge arc comes to occur from the various parts of the front face of an electrode in an anode plate phase. However, in a cathode phase, generating of the discharge arc in the front face of the same electrode comes to be limited only to one in the part of these versatility.

[0004] This behavior is not permitted especially when using a high-pressure electric-discharge lamp for an optical application like projection television. It is necessary to shorten inter-electrode distance extremely for these applications. The reason is that it is necessary to bring a discharge arc close to the point light source. However, since a discharge arc occurs in a mutual cathode phase by shortening inter-electrode distance extremely from the part where electrodes differ, it becomes unstable among [all] a discharge arc, therefore a flicker becomes very strong.

[0005]

[Problem(s) to be Solved by the Invention] Let it be a technical problem for this invention to control remarkably the flicker (fluctuation of a discharge arc) generated while a high-pressure electric-discharge lamp lights up in the high-pressure electric-discharge lamp lighting device which it is made [lighting device] in view of the above points, and the alternating current lamp current of low frequency is supplied [lighting device] to a high-pressure electric-discharge lamp, and makes a high-pressure electric-discharge lamp turn on.

[0006]

[Means for Solving the Problem] If it is in this invention, in order to solve the above-mentioned technical problem, as shown in drawing 1 , it is characterized by inserting one period of high frequency operation in a power source E, the high-pressure electric-discharge lamp La, and the high-pressure electric-discharge lamp La just before the polarity reversals for every half period of the alternating current lamp current wave form of low frequency in the high-pressure electric-discharge lamp lighting device which consists of

electronic ballast which supplies the alternating current lamp current of low frequency. Here, it is more desirable than the peak value of the lamp current wave form at the time of low frequency actuation to make high peak value of the lamp current wave form at the time of the high frequency operation inserted just before the polarity reversals for every half period of that. In that case, it is good to make high only the same polarity side as the lamp current in front of polarity reversals, or to enlarge time amount width of face of the part. Moreover, two or more periods of high frequency operation may be inserted, and it sets in that case, and only the same polarity side as the lamp current in front of polarity reversals may make high peak value of the lamp current wave form at the time of high frequency operation, or only the last period may enlarge time amount width of face. In addition, the alternating current lamp current of low frequency is rectangular current about 1kHz or less, and it is set as the frequency suitable for making the temperature of lamp two electrodes equalize for a moment about the frequency of high frequency operation.

[0007]

[Embodiment of the Invention] (Gestalt 1 of operation) The circuit diagram of the gestalt of the first operation is shown in drawing 1 . Hereafter, the circuitry is explained. The end of a switching element Q1 is connected to the positive electrode of DC power supply E, and the end of a choke coil L1 and the cathode of diode D1 are connected to the other end of a switching element Q1. The anode of diode D1 is connected to the negative electrode of DC power supply E. A switching element Q1, a choke coil L1, and diode D1 constitute the down converter 1. The other end of a choke coil L1 is connected to the end of a capacitor C1 through ammeter **. The other end of a capacitor C1 is connected to the negative electrode of DC power supply E through the resistance R1 for current detection. The direct current voltage charged by the capacitor C1 is impressed to the series circuit of switching elements Q2 and Q3, and the series circuit of switching elements Q4 and Q5. The end of the high-pressure electric-discharge lamp La is connected at the node of switching elements Q2 and Q3. The other end of the high-pressure electric-discharge lamp La is connected to the other end of switching elements Q4 and Q5 through ammeter ** and the high-pressure generating circuit 7. The high-pressure generating circuit 7 generates the high-pressure pulse for starting the high-pressure electric-discharge lamp La using the direct current voltage of a capacitor C1, and suspends generating of a high-pressure pulse after starting.

[0008] The wave of each part at the time of lamp lighting of the gestalt of this operation of operation is shown in drawing 2 . The current to which (a) flows in a lamp current wave form among drawing, and (b) flows to a choke coil L1, and (c) are [the control signal of switching elements Q3 and Q4 and (e of the control signal of switching elements Q2 and Q5 and (d))] the control signals of a switching element Q1. In drawing 2 , although illustration is omitted about the center section of the direction of an axis of abscissa (time-axis), the wave of the part which omitted this illustration serves as a wave-like repeat currently drawn just before

that and on immediately after.

[0009] With the gestalt of this operation, the pressure of the electrical potential difference supplied from DC power supply E is made to lower with a down converter 1, and an electrical potential difference is stored in a capacitor C1. And a high-pressure pulse is impressed to Lamp La by the high-pressure generating circuit 7, and a lifting and discharge are started in dielectric breakdown by inter-electrode. The charge currently stored in the capacitor C1 flows into Lamp La at a stretch after discharge starting. Then, the electrical-potential-difference detector 2 and the current detector 3 detect the electrical potential difference of Lamp La, and a current, the power supplied to Lamp La by the power arithmetic circuit 4 is calculated, it feeds back to a down converter 1 through the PWM control circuit 5, the pulse width of a down converter 1 is controlled, and power is supplied to Lamp La. A capacitor C1 is a smoothing capacitor for reducing the high frequency ripple current by the down converter 1. Moreover, a control circuit 6 detects the peak current which flows to a choke coil L1, and is also controlling the frequency while it controls the polarity-reversals circuit which consists of four switching elements Q2-Q5.

[0010] Actuation of each switching elements Q1-Q5 at the time of a stationary point LGT is as drawing 2 , and is a general full bridge circuit which operates for every half period in the pair of switching elements Q2 and Q5 and switching elements Q3 and Q4. If a switching element Q1 will be in ON condition, the current which flows to a choke coil L1 will go up to an upward slant to the right, if the peak current value made to specify in a control circuit 6 is reached, a switching element Q1 will be turned off and, as for the current of a choke coil L1, the lower right will decrease in number to **. And when the current value of a choke coil L1 becomes zero, a control circuit 6 detects and a switching element Q1 is made to turn on again. This is performed repeatedly.

[0011] As it is the square wave actuation of those other than the time of polarity reversals which the polarity of a lamp current usually reverses by low frequency about 1kHz or less about the actuation at the time and is shown in drawing 2 (c) - (e) When switching elements Q2 and Q5 are turned on and off in the condition that switching elements Q3 and Q4 are off, by ON and a switching element Q1 is turned on and off by the RF The condition that the electrical potential difference of a capacitor C1 is impressed to Lamp La with one polarity, and when switching elements Q2 and Q5 are off and a switching element Q1 is turned on and off by the RF in the state of ON of switching elements Q3 and Q4 The condition that the electrical potential difference of a capacitor C1 is impressed to Lamp La with the polarity of another side is reversed by turns by low frequency.

[0012] The gestalt of this operation is characterized by only one period performing high frequency operation just before the polarity reversals of the square wave actuation which the polarity of a lamp current reverses by low frequency. That is, a polarity is reversed for high frequency actuation (it operates by the pair of switching elements Q2 and Q5 and switching

elements Q3 and Q4, and the switching element Q1) 1 period deed and after that by five switching elements Q1-Q5 just before polarity reversals. Thus, by carrying out high frequency operation a round term just before polarity reversals, the temperature of lamp two electrodes can be made to be able to equalize for a moment, and the flicker (fluctuation of the discharge arc after polarity reversals) generated while the high-pressure electric-discharge lamp La lights up can be controlled.

[0013] (Gestalt 2 of operation) The wave of each part at the time of lamp lighting in the gestalt of the second operation to drawing 3 of operation is shown. The circuitry of the gestalt of this operation is the same as drawing 1 . In the wave form chart of drawing 3 , the current to which (a) flows in a lamp current wave form, and (b) flows to a choke coil L1, and (c) are [the control signal of switching elements Q3 and Q4 and (e of the control signal of switching elements Q2 and Q5 and (d))] the control signals of a switching element Q1.

[0014] By usually raising the current peak value which flows to the choke coil L1 at the time of high frequency actuation in the gestalt 1 of operation with the wave form chart of drawing 3 from the time (even the gestalt [At the time of square wave actuation of low frequency] of the following operations being the same), pass many currents to lamp both ends further, the temperature of two electrodes is made to equalize for a moment, and the discharge arc after reversal is stabilized.

[0015] (Gestalt 3 of operation) The wave of each part at the time of lamp lighting in the gestalt of the third operation to drawing 4 of operation is shown. The circuitry of the gestalt of this operation is the same as drawing 1 . In the wave form chart of drawing 4 , the current to which (a) flows in a lamp current wave form, and (b) flows to a choke coil L1, and (c) are [the control signal of switching elements Q3 and Q4 and (e of the control signal of switching elements Q2 and Q5 and (d))] the control signals of a switching element Q1.

[0016] Mitigating the damage to an electrode rather than the gestalt 2 of operation by usually raising from the time the current peak value to which only the same polarity side as the lamp current in front of polarity reversals flows to a choke coil L1 in the gestalt 2 of operation with the wave form chart of drawing 4 , the temperature of an anode plate (after polarity reversals is cathode) is raised, and the discharge arc after polarity reversals is stabilized.

[0017] (Gestalt 4 of operation) The wave of each part at the time of lamp lighting in the gestalt of the fourth operation to drawing 5 of operation is shown. The circuitry of the gestalt of this operation is the same as drawing 1 . In the wave form chart of drawing 5 , the current to which (a) flows in a lamp current wave form, and (b) flows to a choke coil L1, and (c) are [the control signal of switching elements Q3 and Q4 and (e of the control signal of switching elements Q2 and Q5 and (d))] the control signals of a switching element Q1.

[0018] By usually raising from the time the current peak value to which only the same polarity side as a lamp current flows to a choke coil L1 in the gestalt 3 of operation with the

wave form chart of drawing 5 , and enlarging time amount width of face of this part further, the temperature of an anode plate (after polarity reversals is cathode) is raised further, and the discharge arc after polarity reversals is stabilized.

[0019] (Gestalt 5 of operation) The wave of each part at the time of lamp lighting in the gestalt of the fifth operation to drawing 6 of operation is shown. The circuitry of the gestalt of this operation is the same as drawing 1 . In the wave form chart of drawing 6 , the current to which (a) flows in a lamp current wave form, and (b) flows to a choke coil L1, and (c) are [the control signal of switching elements Q3 and Q4 and (e of the control signal of switching elements Q2 and Q5 and (d))] the control signals of a switching element Q1.

[0020] In the gestalt 1 of operation, by carrying out two or more periods of high frequency operation just before polarity reversals, the temperature of lamp two electrodes is made to equalize further for a moment, and the discharge arc after polarity reversals is stabilized with the wave form chart of drawing 6 .

[0021] (Gestalt 6 of operation) The wave of each part at the time of lamp lighting in the gestalt of the sixth operation to drawing 7 of operation is shown. The circuitry of the gestalt of this operation is the same as drawing 1 . In the wave form chart of drawing 7 , the current to which (a) flows in a lamp current wave form, and (b) flows to a choke coil L1, and (c) are [the control signal of switching elements Q3 and Q4 and (e of the control signal of switching elements Q2 and Q5 and (d))] the control signals of a switching element Q1.

[0022] By usually raising from the time the current peak value which flows to the choke coil L1 at the time of high frequency actuation in the gestalt 5 of operation with the wave form chart of drawing 7 , pass a current to lamp both ends further, the temperature of two electrodes is made to equalize further for a moment, and the discharge arc after polarity reversals is stabilized.

[0023] (Gestalt 7 of operation) The wave of each part at the time of lamp lighting in the gestalt of the seventh operation to drawing 8 of operation is shown. The circuitry of the gestalt of this operation is the same as drawing 1 . In the wave form chart of drawing 8 , the current to which (a) flows in a lamp current wave form, and (b) flows to a choke coil L1, and (c) are [the control signal of switching elements Q3 and Q4 and (e of the control signal of switching elements Q2 and Q5 and (d))] the control signals of a switching element Q1.

[0024] Making temperature of two electrodes into homogeneity for a moment mitigating the damage to an electrode rather than the gestalt 6 of operation by usually raising from the time the current peak value to which only the same polarity side as the lamp current in front of polarity reversals flow to a choke coil L1 in the gestalt 6 of operation with the wave form chart of drawing 8 , the temperature of an anode plate (after polarity reversals be cathode) be raise , and the discharge arc after polarity reversals be stabilize .

[0025] (Gestalt 8 of operation) The wave of each part at the time of lamp lighting in the gestalt of the eighth operation to drawing 9 of operation is shown. The circuitry of the gestalt

of this operation is the same as drawing 1 . In the wave form chart of drawing 9 , the current to which (a) flows in a lamp current wave form, and (b) flows to a choke coil L1, and (c) are [the control signal of switching elements Q3 and Q4 and (e of the control signal of switching elements Q2 and Q5 and (d))] the control signals of a switching element Q1.

[0026] Making temperature of two electrodes into homogeneity for a moment by usually raising from the time the current peak value to which only the same polarity side as the lamp current in front of polarity reversals flows to a choke coil L1 in the gestalt 7 of operation with the wave form chart of drawing 9 , and enlarging time amount width of face of this part further, the temperature of an anode plate (after polarity reversals is cathode) is raise further, and the discharge arc after polarity reversals is stabilize.

[0027] (Gestalt 9 of operation) The wave of each part at the time of lamp lighting in the gestalt of the ninth operation to drawing 10 of operation is shown. The circuitry of the gestalt of this operation is the same as drawing 1 . In the wave form chart of drawing 10 , the current to which (a) flows in a lamp current wave form, and (b) flows to a choke coil L1, and (c) are [the control signal of switching elements Q3 and Q4 and (e of the control signal of switching elements Q2 and Q5 and (d))] the control signals of a switching element Q1.

[0028] With the wave form chart of drawing 10 , mitigating the damage to an electrode rather than the gestalt 7 of operation by raising from usual the current peak value to which only the half period of the last in front of polarity reversals flows to a choke coil L1 further, in the gestalt 7 of operation, the temperature of two electrodes is made to equalize for a moment, the temperature of an anode plate (after polarity reversals is cathode) is raised, and the discharge arc after polarity reversals is stabilized by the same polarity side as a lamp current.

[0029] (Gestalt 10 of operation) The wave of each part at the time of lamp lighting in the gestalt of the tenth operation to drawing 11 of operation is shown. The circuitry of the gestalt of this operation is the same as drawing 1 . In the wave form chart of drawing 11 , the current to which (a) flows in a lamp current wave form, and (b) flows to a choke coil L1, and (c) are [the control signal of switching elements Q3 and Q4 and (e of the control signal of switching elements Q2 and Q5 and (d))] the control signals of a switching element Q1.

[0030] Making temperature of two electrodes into homogeneity by enlarging time amount width of face of the part which raised the current peak value which flows to a choke coil L1 in the gestalt 9 of operation with the wave form chart of drawing 11 , the temperature of an anode plate (after polarity reversals is cathode) is raised further, and the discharge arc after polarity reversals is stabilized.

[0031]

[Effect of the Invention] As mentioned above, according to this invention, there is effectiveness which can control remarkably the flicker (fluctuation of a discharge arc) generated while a high-pressure electric-discharge lamp lights up by making homogeneity

carry out temperature of two electrodes just before polarity reversals for a moment, or raising the temperature of an anode plate, i.e., the temperature of the cathode after polarity reversals.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the circuit diagram of the gestalt of operation of the first of this invention.

[Drawing 2] It is a wave form chart for explanation of the gestalt of operation of the first of this invention of operation.

[Drawing 3] It is a wave form chart for explanation of the gestalt of operation of the second of this invention of operation.

[Drawing 4] It is a wave form chart for explanation of the gestalt of operation of the third of this invention of operation.

[Drawing 5] It is a wave form chart for explanation of the gestalt of operation of the fourth of this invention of operation.

[Drawing 6] It is a wave form chart for explanation of the gestalt of operation of the fifth of this invention of operation.

[Drawing 7] It is a wave form chart for explanation of the gestalt of operation of the sixth of this invention of operation.

[Drawing 8] It is a wave form chart for explanation of the gestalt of operation of the seventh of this invention of operation.

[Drawing 9] It is a wave form chart for explanation of the gestalt of operation of the eighth of this invention of operation.

[Drawing 10] It is a wave form chart for explanation of the gestalt of operation of the ninth of this invention of operation.

[Drawing 11] It is a wave form chart for explanation of the gestalt of operation of the tenth of this invention of operation.

[Description of Notations]

1 Down Converter

2 Electrical-Potential-Difference Detector

3 Current Detector

4 Power Arithmetic Circuit

5 PWM Control Circuit

6 Control Circuit

La Lamp (high-pressure electric-discharge lamp)